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ABSTRACT

The purpose of this study was to systematically examine the cognitive and social effects of the use of microcomputers with kindergarten children in the school and at home. Three schools received microcomputers for use in kindergarten classrooms and each student in one of the classrooms was provided a PCjr and educational software to use at home. Software used by the children consisted of games, simulations, and drill and practice programs that coincided with the goals of the kindergarten curriculum. Two additional schools served as control groups. It was hypothesized that computer-using classrooms would make larger academic gains than the other classes. It was also expected that the home use group would gain more than the classroom use only group. The impact of the use of microcomputers was assessed by a criterion referenced pre- and post-test based on the objectives of the school district's kindergarten curriculum guides. The test included subsections concerning reading readiness, mathematics, Piagetian cognitive operations, and keyboard knowledge. Findings indicated that the use of microcomputers in the classroom facilitated the acquisition of school readiness skills. When supplemented by concurrent computing activities at home, academic gains were even greater. No indication was found that computing experiences interfere with the normal cognitive development of preschoolers, and no gender-related differences in cognitive gains achieved were found. (RH)

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Microcomputer Use in Kindergarten and at Home:

Design of the Study and

Effects of Computer Use on School Readiness

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Introduction

The questions of how and when to introduce computing into the public school curriculum are current topics of research and debate among educators and educational researchers. Proponents of the use of microcomputers in early childhood education claim that providing students with computing experiences will facilitate and perhaps accelerate cognitive development (Papert, 1980). Specific problem solving skills are seemingly fostered by the use of Logo with preschoolers (Clements, 1985; Clements & Gullo, in press; Perlman, 1976). Academic gains for preschoolers using microcomputers as tutors for instruction in specific subject areas have also been reported (Hungate, 1982; Lieberman, 1985; Lin, Vallone & Lepper, 1984). In addition, computing appears to be a highly social preschool activity when students are given the option of working in pairs (Becker, 1984-5; Muller & Perlmutter, 1984; Perlmutter, Behrend & Muller, 1985).

Other professionals argue that young children are not developmentally ready to benefit from the individualized world of symbols and abstract information that computers offer (Barnes & Hill, 1983; Cuffaro, 1984; Schwartz, 1985). The underlying premise is that preschoolers learn best from real experiences, direct participation and sensory exploration of the environment. The manipulation of three dimensional objects is considered necessary for connecting sensorimotor schemata to abstract concepts and for establishing causal relationships. In addition, the use of microcomputers is not thought to foster social interactions, which are necessary components in concept and

language development.

The purpose of our study was to systematically examine the cognitive and social effects of the use of microcomputers with kindergarten students in the natural field settings of school and home. The project was designed to investigate outcomes when teachers were given relative freedom to use the machines to further their own curricular goals and philosophies. The software that was selected for use consisted of games, simulations and drill and practice programs that coincided with the goals of the kindergarten curriculum.

The objectives of the study were to examine

1. the effects of microcomputer use in school and in the home on the development of school readiness skills
2. the effects of microcomputer use on motivation and social behavior of students
3. the response of families to students' use of computers
4. teacher implementation strategies
5. gender differences in computer use.

This paper is concerned with the effects of school and home use of microcomputers on the development of school readiness skills. A traditional pre-post design was utilized. Three schools received microcomputers for use in kindergarten classrooms. Each student in one of these classrooms was also provided with a PCjr and educational software to use at home. Two additional schools within the district served as control groups. It was hypothesized that computer using classrooms would make larger academic gains than the non-computer using classes. It was also expected that the home-use group would gain more than the classroom-use-only group.

<insert design diagram>

Method

Subjects

Five different schools within the Cupertino Union School District were selected to participate in the study and included a large proportion of students from the middle range of socioeconomic backgrounds. Difference scores were computed for 186 kindergarten students who had taken both the pretest and posttest. This group was slightly smaller than either the pretest or the posttest groups. This distinction should be noted, as some analyses to be reported later use the larger samples.

Materials

Pre/posttest.

The impact of the use of microcomputers was assessed by a criterion-referenced test based on the objectives of the district's kindergarten curriculum guides. This instrument included four subsections: reading readiness, mathematics, Piagetian cognitive operations and keyboard knowledge. Items within each subarea were arranged in order of difficulty. The overall reliability of the test was determined to be .87 (or above), using Cronbach's alpha as a measure of internal consistency. The matching of test items to the goals of the kindergarten curriculum contributed to the high content validity of the instrument.

Software.

Software for the project was selected on the basis of correspondence to the objectives of the kindergarten curriculum. A detailed analysis of the curriculum goals, software objectives and test items was conducted in order to insure a software/curriculum/test match. Additional criteria for software selection were

- interactivity (a high ratio of user activity to system activity)
- individualized instruction
- accommodation of a range of ability levels
- sufficient variation to offer instruction throughout the school year.

A software selection panel, composed of representatives from the district, the research team, IBM and two outside experts, reviewed and selected software programs to be used in the project. Choices were limited by the scarcity of age-appropriate software for the PCjr. Not every program met all selection criteria, but each piece of software did reflect the goals of the district's kindergarten curriculum. A total of eleven programs were selected; most of these were in the area of reading readiness. Figure 2 shows the distribution of software across curricular areas.

<insert Figure 2>

Procedure

Students in both computer-using and comparison groups were pretested in December and posttested in May. Test administrators were selected from a district list of substitute teachers and classroom aides and were trained by members of the research

team.

For purposes of administration, the test was divided into three sections: reading readiness, mathematics and Piagetian/keyboard. Each part was administered individually at a designated center at each school and took approximately fifteen minutes to complete. Each tester gave only one section of the test; students were tested by three different test administrators.

At the completion of the pretesting, IBM PCjrs were installed in three schools at a ratio of one microcomputer to six students. Two weeks before the machines were placed in the classrooms, teachers were trained by the district project coordinator on the operation of the micros and use of the software. Teachers were also given PCjrs to use at home. Training and the opportunity to use the equipment on their own gave these inexperienced computer-using teachers a sense of control and added to their comfort level regarding the use of microcomputers.

A guideline of a minimum of one hour a week per student of computer instruction was established. Teachers differed in their means of incorporating computing time into the instructional day and in the patterns of student use of microcomputers.

Results

School readiness gains varied by area of assessment. A series of oneway ANOVAs were conducted to determine differences among the home-use, classroom-use and comparison groups. The

home-use group differed significantly in reading readiness ($M = 11.23$) from the classroom-use only group ($M = 4.38$) which in turn differed significantly from the comparison group ($M = 1.88$) $F(2, 183) = 11.16, p < .00$. (See Figure 3.) Computer-using groups gained significantly more than control groups in the areas of reading readiness ($M = 6.09$ and 1.88 , respectively) $F(1, 184) = 10.93, p < .001$ and keyboard knowledge ($M = 7.73, 1.30, F(1, 184) = 130.12, p < .00$). (See Figures 4 and 5.) No significant gain score differences were found in mathematics or Piagetian tasks. Overall school readiness gains were significantly different for computer-using groups ($M = 14.35$) and the control group ($M = 8.93$), $F(1, 184) = 10.54, p < .001$.

The gains for computer-using groups are software-specific and can be attributed to the greater availability of particular types of software. Ten programs pertaining to reading readiness were used, one of which also included mathematics. Only two mathematics programs were found that were age appropriate. One of these programs did not become available until late in the project. It was not expected that experience with computers would affect mental operations of the sort required to perform well on Piagetian tasks. This assessment of cognitive operations was included to examine the argument that computer experience might actually be detrimental to the general cognitive development of young children. While the computer-using groups tended to gain more on Piagetian tasks ($M = 2.85$) than the control group ($M = 2.40$), the difference is slight and not statistically significant. Each of the programs reinforced the development of keyboard skills.

It should be noted that the computer-using group was slightly lower at pretest than the comparison group in the areas of reading readiness ($M = 25.77$ and 29.37) $F(1,104) = 8.18$, $p < .005$, mathematics ($M = 14.55$ and 16.00) and Piagetian tasks ($M = 13.91$ and 14.30). Gain scores tended to be negatively related to pretest ratings: students who scored lower on the pretest generally gained more than those who initially performed at a higher level. Inspection of the frequency distributions of composite scores indicated that this is not the result of a "ceiling effect" problem. It was possible for students who started at a relatively high level to score even higher on the posttest. The gains that favored the computer group were only in the reading and keyboard areas, suggesting that the results are not attributable to a regression toward the mean.

However, to examine this possibility, each student in the home-use class was matched on pretest reading readiness score with a student in the classroom-use group and one in the control group. Subjects were equated by gender when possible. A oneway analysis of variance on the resultant home-use ($M = 21.73$), classroom-use ($M = 22.05$) and control groups ($M = 21.50$) revealed no significant differences in group pretest reading readiness scores, $F(2, 63) = .02$, $p = .98$. A series of oneway ANOVAs were then conducted on the gain scores of the comparable subsets in the areas of reading readiness, mathematics, Piagetian tasks and keyboard knowledge. The results confirmed our original findings. Mean reading readiness gain scores were 11.23 for the home-use group, 6.18 for classroom-use and 2.50 for the control

group; the analysis of variance indicated a significant difference in group reading readiness gains, $F(2, 63) = 4.37, p < .01$. Mean keyboard gain scores were 7.73 for home-use, 7.91 for classroom and 1.05 for control groups; a significant difference was found among keyboard gain scores of the three groups, $F(2, 63) = 23.27, p < .0001$. No significant gains were found in the areas of mathematics and Piagetian tasks.

Although there were significant differences between boys and girls in some of the pretest and posttest scores, the use of microcomputers did not affect girls or boys differentially. A twoway analysis of variance with an interaction hypothesis indicated that there was no significant interaction of gender with treatment.

DISCUSSION

Several conclusions may be drawn from our study. The use of microcomputers in the classroom facilitates the acquisition of school readiness skills in kindergarten students. When supplemented by concurrent computing activities at home, academic gains for young children are even greater. We found no indication that computing experiences interfere with the normal cognitive development of preschoolers. Our study also revealed no gender-related differences in the cognitive gains achieved from use of the machines with this age group. Kindergarten girls seem to interact as competently as boys with microcomputers.

These results from the field replicate those of more carefully controlled studies in which the curriculum and instructional decisions are under the control of the research

team. While teachers worked within the constraint of a minimum of one hour a week of computing time per student and were given specific software to use, methods of implementation varied by instructor. The presence of microcomputers in the classroom throughout the instructional day and the low student/micro ratio enabled the teachers to use the software prescriptively and to arrange the machines as learning centers in each classroom. By the end of the study, teachers stated that microcomputers had become an integral part of the curriculum. Use of the machines was viewed as another exciting way for students to learn core concepts and basic skills. This stance contrasts sharply with these teachers' previous lack of involvement in structuring microcomputer learning experiences when students attended the schools' computer labs.

Academic gains were software-specific and directly related to the availability of programs within the various curricular areas. We do not know what the effects of more mathematics software would have been. The influence of home use is also not easy to disengage from other effects. It appears that school readiness gains are proportional to the amount of time spent at microcomputers, but this possibility can only be assessed through continued research with a larger number of classrooms. Future studies might also examine the impact of the use of microcomputers on kindergarten students from low income or non-English speaking minority backgrounds. Longitudinal studies will be necessary to assess the possibility that school readiness gains derived from the use of microcomputers in kindergarten will

extend to later performance in school. While we do know that microcomputers are proving to be effective instructional devices for young children, there are still many unanswered questions. The results of our study contribute to the growing file of knowledge in the field.

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